

# White Paper Report

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**Final Report**

Grant Number: PF-50252-12

Project Title: Space Planning: The Final Frontier

Project Director: Eunice Haugen

University of Minnesota, Twin Cities, Goldstein Museum of Design

Date Submitted: December 16, 2013

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Final Report for **Space Planning: The Final Frontier**

**Grant Project**

The goal of Goldstein Museum of Design's (GMD's) National Endowment for the Humanities Sustaining Cultural Heritage Collections Planning Grant project was to develop a construction ready plan for the renovation and refurbishment of the museum's largest collection storage area, room 255A McNeal Hall located on the St. Paul Campus of the University of Minnesota.

**Background—what's the problem?**

GMD is part of the College of Design at the University of Minnesota (GMD, CDes, UMN) and occupies a portion of McNeal Hall. The collection storage area (Room 255A McNeal Hall) the subject of the project was built out as part of the 1975 addition to McNeal Hall. This included the development of the store room that is the subject of this grant and the museum's gallery and small workspace. The 1260 square foot room houses 13,000 objects or approximately 45% of the collection; approximately 3850 textiles and 9150 non-label historic costume (apparel). Items stored in this area are some of the oldest and most fragile within the collection.

These 13,000 objects are stored in 70 non-archival cabinets made of plastic laminate covered particle board. In addition there are six circa 1920's-50's wood cabinets that store children's apparel, wedding dresses, under garments and hats. Stacked on top of the cabinets are 428 boxes containing approximately 3,600 objects. The boxes are a combination of acid free and non-acid free textile and hat boxes, and vary in size and content. Boxes are stacked four to five high, making retrieval of objects difficult and potentially perilous to both the objects and museum staff. Although storage on top of cabinets is not ideal, growth in the collection has made it necessary to absorb this valuable space. Ductwork and suspended lighting are located directly above the cabinets, absorbing up to two feet of space and if left as is would limit the height of new cabinetry.

Both cabinets and boxes are overcrowded, some boxes contain up to 195 items and cabinets may have up to 50 garments on hangers in a 40" space. Overcrowding in boxes creates issues of access and over handling of objects, and is not only time consuming for the staff, but puts undue stress on objects. Additionally cabinets are too shallow for full skirted historic garments and hanging too many items in one cabinet does not allow sufficient space for garments to hang freely. Having ample space for each garment lessens the risk of damage of crushing and/or abrasion from other garments and is necessary as overcrowding can put objects at risk when retrieving for study or exhibition.

Seventy five percent (57) of the cabinets are outfitted for hanging apparel and hold approximately 38% (3,460) of the historic apparel. Most cabinets with hanging rods also have one open shelf for hats and other accessories at the top. The remaining cabinets house textiles that are either rolled or folded on shelves in closed cabinets. Some textiles are stored flat in boxes. Access to textiles can be difficult since multiple textiles have been rolled together on one roll or many may be stored in one box or shelf. Furthermore, many items that are folded would benefit from being rolled and in a more stable enclosed environment.

## **Goal—what we wanted to achieve?**

The goal was to develop a plan to house all objects within Room 255A in non-reactive cabinetry and maximize the available storage space. A successful plan would have been one that facilitated optimal efficient organization and object preservation, allowed for collection growth, relieved object crowding, and provided safer and easier access to a significant portion of the museum's collection. Providing apparel and textiles with storage that reduces the kind of stresses that occur with crowding, over-stacking, and subsequently over-handling significantly impacts the long-term preservation of objects.

## **Process—what was done?**

The planning process broke down into three phases; research, design and budgeting and development of a plan.

### **PHASE ONE—RESEARCH**

Within Phase One, GMD's registrar, Eunice Haugen evaluated the number and types of objects to be stored, and worked with textile conservator Beth McLaughlin to determine storage methods by types of objects. Eunice and Beth evaluated cabinet vendors that specialize in the museum collections storage cabinetry and selected to work with Delta Designs Ltd., a frontrunner in the field of museum storage systems. Delta cabinets are all steel construction with a non-reactive solvent-free baked powder coat finish, have mechanically attached silicone gaskets, flush locking hardware, a full length door piano hinge and passive filter vents. Cabinets are designed to accept drawers on metal glides, drawers on ball bearing extension suspensions, shelves, roll storage racks, and garment rods and are adaptive to compact storage systems.

GMD contracted with Questions and Solutions Engineering Inc. (QSE) who specialize in the design of heating ventilations and air-conditioning (HVAC) systems within museums. Rebecca Ellis and Steph Gallatin of QSE met with GMD staff and UMN facilities staff to understand the history of the museum and its facilities, the environmental control goals, the actual environmental conditions achieved throughout the year, the problems experienced and solutions attempted to date, and the operational arrangement between the museum and the University of Minnesota Facilities.

### **PHASE TWO—DESIGN**

Storage: GMD's registrar used object data collected in the Phase One to calculate the number of cabinets required and the number and types of shelves, drawers and hanging rods required to house the collection. Much was based on the linear feet and cubic feet of the existing cabinetry and then increased the space allotment for object storage when and where space was available or deemed necessary.

GMD worked with Haldemann-Homme Inc. (HHI) a locally based national supplier of work place and industrial storage systems and a distributor of Delta Designs museum cabinets. HHI assists clients with space planning, design, layout and installation of large storage installations. In addition, Delta Design and HHI work in tandem with Spacesaver, a vendor of mobile shelving and compact storage systems. Compact storage systems consist of mounted shelving or cabinets on systems of rails on which the cabinets slide back and forth with the aide of an electric motorized system or hand crank. Such systems allow for a greater number of cabinets in a smaller space since there are usually only one or two aisles in

an entire layout. In this case, Delta Design is the vendor of the cabinetry and Spacesaver provides the mechanical and physical system on which the cabinets “ride”.

The finished cabinet plan included a total 121 cabinets ranging in height of 23” – 79”, nine units of open shelving to accommodate textile boxes and/or rolled textile storage and total of 346 drawers and 18 shelves. Cabinets would be stacked in various configurations with an overall total height of 9 ft. The majority of cabinets were to be 32” deep which is an increase of six inches over the existing cabinets. Three cabinets were designated to be 40” deep and would house fragile historic garments that are currently folded in boxes. These garments would be stored flat in shallow drawers with ideally one object per drawer. Fifty four cabinets were to house hanging garments and the remaining cabinets would have full extension drawers for flat storage of smaller garments and textiles. Cabinets would be configured in nine rows of five cabinets each and would be on the Spacesaver system with a stationary row on each end, between columns and an additional four stationary cabinets running perpendicular to the main area of storage. Within a compact storage system, all cabinets within a row are coupled together and move on the rail as one large unit. Open space was allocated to accommodate storage of rolling ladder, apparel racks and carts. Additionally, the four stationary cabinets between the columns are 42” tall which allows a work space for staff to place an object for examination or to roll a textile.

Environmental Control HVAC: Questions and Solutions Engineering Inc. evaluated existing environmental conditions equipment and believe that the current 29 year old HVAC system is oversized for the museum’s environmental control requirements and that energy can be saved with a new system by reducing total airflow to better match the needs of the museum. Similarly, the cooling capacity of the existing unit is nearly twice what is required for the spaces to be controlled. Right-sizing the cooling system should reduce electrical demand in the building and allow for more even temperature control for the museum.

Both QSE and UMN facilities staff recommended the replacement of the existing HVAC unit and its roof-mounted condensing unit. QSE also is proposing the reconfiguring the collections storage supply and return ductwork to accommodate the new compact storage system. In addition a new system must include provisions for fresh air ventilation to the museum spaces. This fresh air ventilation will serve to slightly positively pressurize the museum spaces. This is desirable for improving collections environmental control. QSE recommends replacing the existing HVAC unit with a new, high efficiency 10 ton (4,000 CFM) unit to serve all Goldstein Museum spaces using the existing distribution duct system (with the exception of the reconfigured Collections Storage ductwork). Replacing this unit will not only reduce the cost of operation and environmental impact, but will also aide in the long term preservation of objects.

Environmental Parameters: Textile Conservator Beth McLaughlin made the following recommendations for environmental conditions for collections storage of textiles. These recommendations are based on the guidelines produced by the Canadian Conservation Institute (Canadian Conservation Institute. *Textiles and the Environment*. CCI Notes 13/1. Ottawa: Canadian Conservation Institution, 2013.)

Relative Humidity: The most recent Hobo Temperature and RH Data Logger recording of the relative humidity (RH) in Room 255A over seven and a half months in 2013 (March 8 through October 28) indicates an average of 48.5% with maximum RH at 65% and minimum at 24%. The low RH was during the cold months. Ideal relative humidity is 50% with fluctuations of +/- 5 percent. Textiles can withstand very gradual and limited fluctuations in temperature and RH, but extremes can be damaging: high RH levels (over 60%) can encourage fungal growth, while low RH levels (below 20%) can lead to the desiccation and embrittlement of natural fibers and feathers. Textile fibers have a capacity for retaining

a certain level of moisture. As the surrounding relative humidity fluctuates, it causes the textile to react. A high relative humidity causes textile fibers to swell with absorbed water and initiate reactions such as dye bleeding, yellowing, browning and biological deterioration (mold). Low relative humidity will cause the fibers to release moisture and shrink. Rapid changes in the relative humidity causes rapid shrinking and swelling in the materials, resulting in damage to the fibers. Some variation in RH is acceptable, but wide fluctuations within short periods of time should be avoided. The damage created by the above-mentioned factors is cumulative and irreversible. Additionally, proximity to many metals needs to be considered, even items such as buttons may have to be isolated in composite objects. Under humid conditions metals can rust, corrode and cause staining.

Temperature: The most recent Hobo Temperature and RH Data Logger recording of the temperature in Room 255A over seven and a half months in 2013 (March 8 through October 28) indicates an average temperature of 71.1 degrees Fahrenheit with maximum temperature of 75.7 and minimum of 61.4 degrees Fahrenheit. The greatest difference in temperature occurred during scheduled power outages in the middle of June, factors beyond the control of the museum. Colder storage is ideal for textiles, with guidelines of approximately 60-68 degrees Fahrenheit in winter and 68-75 degrees Fahrenheit in summer. Storage areas however can be cooler with a guideline of 50 to 55 degrees Fahrenheit. Items with fur can require lower temperatures. For fibers, lower temperatures are preferable since each 10 degree rise in temperature can cause the rate of a chemical reaction to double.

UMN Interaction: Project Director Eunice Haugen has had past experience with management of museum collection storage and gallery construction projects at other museums; she was not aware of the complex process and related costs for construction planning and implementation required within the UMN system. Haugen had contacted a UMN Facilities Management Area Coordinator prior to the submission of the grant but it was not until receipt of the grant that it was understood that all construction projects within the University of Minnesota require an assigned Capital Planning and Project Management Coordinator and that all services provided by the UMN Capital Planning Project Coordinator, Facilities Maintenance and Management staff, UMN Architect, Structural Engineer and Mechanical Engineer services are billed to the associated department and that all costs associated with the project are re-budgeted through the office of Capital Planning and Projects Management. This unexpected cost was covered by eliminating the budget line item of the part time Assistant Registrar and the additional work load was absorbed by the Registrar. This budget change was approved by NEH Senior Program Officer Mary Downs.

Haugen worked with UMN Capital Planning and Project Management Coordinator, Roger Wegner for the duration of the planning process. Wegner assisted with the navigation of the extensive UMN Facilities system, saw that all the necessary staff were involved with the planning discussions and process, oversaw the details of the construction planning and managed the internal budget for construction planning.

GMD staff worked with Interior Designer and Space Planner Ann Kastensen to develop construction documents and to select finish choices for flooring and paint.

### **Reality – The “best-laid plans of mice and men oft(en) go astray.”**

Despite the fact the basic plan was completed, it was determined that implementation of the plan was not feasible in its entirety. Through the final design and engineering process Joseph Jameson, UMN Principal Engineer Supervisor Facilities Management, determined that the structural load rates of McNeal Hall did not meet code requirements to support the compact storage system and its contents.

Alternate plans were explored to work around this obstacle; one option was to forgo the compact portion of the storage system and install stationary cabinets. In this scenario the weight of the cabinets and contents would be at a constant and would be dispersed over a greater area and fall within acceptable code guidelines. The second scenario was to add significant structural support to approximately one half of the room. The proposal was to create a subfloor of steel beams; this would be attached to existing columns and would support the compact storage system. It was not possible to create a substructure within the entire space since the span of the columns extends beyond the perimeter of the room, bisecting a public hallway which could not be permeated and a classroom which could not be absorbed into our plan. Additionally in each alternate scenario the revised floor plan could not accommodate the number of cabinets required to house the collection. Pursuing added storage space within McNeal hall was not an option. It was also thought by GMD staff that adding structural support did not seem prudent due to the increased cost and not a responsible use of resources since the long term strategic plan of the College of Design is to relocate the museum and the college within the next 5-10 years. Whereas storage cabinets and even portions of a compact system floor system could be reused in a new location, the structural improvements required would be very site specific and not adaptive to any other use or location.

### PHASE THREE– BUDGETING AND DEVELOPMENT OF PLAN

Prompted by the receipt of this NEH planning grant, the College of Design allocated \$200,000 to GMD toward the renovation of Room 255A McNeal Hall and the rehousing of objects stored in this room. Part of the intended result of the planning process was to apply for additional funding from the NEH and/or Institute of Museum and Library Services for implementation. Due to the inherent structural load rate deficiency of the building it was determined to not pursue additional funding at this time and to make what improvements can be made with the \$200,000 in hand. Additional funding will be sought for smaller portions of the projects such as rehousing all hats in acid free archival boxes and the purchase of additional archival boxes and materials for the rehousing of textiles.

Within the revised plan, the HVAC system would be replaced with the new unit discussed earlier and ductwork would be rerouted to allow greater ceiling height for storage. Thirty-three cabinets would be replaced with a combination of Delta cabinets, open shelving to accommodate 18"x 40" textile boxes and open cantilevered units for the storage of rolled textiles. This would rehouse approximately 3000 objects, 1800 apparel and 1200 textiles. Existing fluorescent lights which currently hang from chains would be ceiling mounted. Additionally, areas within cabinets would be examined for consolidation or reorganization to maximize space that cannot be replaced. Additional funding will be sought to further the preservation of and safe storage of objects stored within this room.

This work will take place over the summer of 2014. The adjoining gallery space will be closed for exhibitions and used as temporary object storage area during the installation of the new HVAC system, rerouting of ductworks, remounting of lighting fixtures, removal of cabinetry and installation of new cabinetry and shelving. The budget for this project has not been finalized.

Although this project did not generate quantifiable data demonstrating increase in audience attendance or engagement, the preservation of museum objects allows for the continued use of objects in exhibitions, education and research. Our audience is greatly comprised of the College of Design and University of Minnesota population of over 68,000 students, faculty, and staff as well as the metro Minneapolis /St. Paul areas which in a community of 2.6 million people in a design-vibrant state of approximately 4.9 million. Students, faculty, researchers, and designers visit GMD's exhibitions and

study collection objects onsite by appointment. This includes faculty and students at a dozen area colleges and universities, teachers at primary and secondary schools, and program providers who serve adult learners.

Appendices:

Questions and Solutions Engineering - final report

Fiber Art Preservation LLC – final report

Room 255A Climate Chart

Cabinet layout – compact storage

Cabinet layout – revised





July 29, 2013

Ms. Eunice Haugen  
Registrar/Materials Library Coordinator  
Goldstein Museum of Design  
College of Design  
333 McNeal Hall  
1985 Buford Avenue  
St. Paul, Minnesota 55108

RE: Collections Storage Renovation  
Goldstein Museum of Design  
HVAC System Assessment

Dear Ms. Haugen:

Questions & Solutions Engineering, Inc. (QSE) is pleased to present this report of our findings and recommendations for upgrading the heating, ventilating and air conditioning (HVAC) system for the Goldstein Museum of Design at the University of Minnesota in St. Paul. These upgrades are recommended to improve temperature and relative humidity control for the long term preservation of your collections and for the comfort of staff and visitors.

## Introduction

The Goldstein Museum of Design is located in McNeal Hall and was originally constructed around 1975. The 3<sup>rd</sup> Floor of the building appears to have originally been designed as classroom/laboratory spaces which were converted in 1984 to provide space for the Goldstein Museum. Three spaces were designed and constructed with special environmental controls for enhanced year-round, 24/7 temperature and relative humidity control. The spaces are the Gallery, the Workroom, and the Collections Storage Room.

The Museum is planning a renovation of the Collections Storage Room to replace the current shelving with compact storage. There is distribution ductwork throughout the Collections Storage Room that will need to be reconfigured to make room for the new compact shelving. In addition, the existing museum HVAC unit has reached the end of its life cycle, and the Museum wants to explore options to replace/upgrade the existing HVAC system in order to improve environmental conditions in the Collections Storage Room.

This report summarizes QSE's findings and recommendations for HVAC system modifications to better preserve the Goldstein Museum's collection. These recommendations and their costs will be taken into consideration when determining the final disposition of the facility.



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## Assessment Process

QSE performed the following building and HVAC system assessment activities:

1. Rebecca Ellis and Steph Gallatin visited the Museum on February 13, 2013 and performed the following activities:
  - a. Met with museum representatives to understand:
    - i. The history of the Museum and its facilities
    - ii. The environmental control goals for the three Museum spaces
    - iii. The actual environmental conditions achieved throughout the year
    - iv. The problems experienced and solutions attempted to date
    - v. Operational arrangement between the Museum and the University of Minnesota Facilities Management Department
  - b. Reviewed available building systems documentation:
    - i. Building floor plans and sketches
    - ii. Architectural and Mechanical Drawings
  - c. Toured, measured, and photographed the Museum spaces
  - d. Observed the existing HVAC system components and configuration
  - e. Traced the existing ductwork to the best of our ability
2. New HVAC System Recommendations:
  - a. QSE identified a range of recommendations and options for improving indoor environmental control.
  - b. QSE estimated the implementation cost for each recommendation and option.
  - c. QSE analyzed the benefits of each option, including impact on indoor environmental control, annual energy costs, reliability and maintainability.
3. This report is the culmination of QSE's HVAC system assessment.

## Existing Conditions

### General

The Goldstein Museum of Design currently encompasses about 3,200 square foot on the 3<sup>rd</sup> Floor of McNeal Hall. The Museum's 29 year old HVAC system currently consists of a Liebert air conditioning unit with integral direct expansion refrigerant (DX) cooling, electric heating (3-elements), humidification, and dehumidification capabilities. The Liebert unit system was original to the 1984 renovation. QSE found no outside air ventilation introduced to the Museum spaces. Liebert unit or directly ducted to the museum from a dedicated makeup air unit. Refer to Figures 1-3 attached to this report for photos of the Museum air handling unit.

The Liebert Model UH245A-C01 (20 tons of cooling) is located in a mechanical room adjacent to the Workroom and the Gallery. Conditioned air from the Liebert unit is distributed to each space through overhead ductwork. Supply air ducts are tied into the top of the unit and leave the mechanical room through the adjacent wall to the Workroom.

The Liebert DX system condensing unit is located outdoors on the roof above the Mechanical Room.

The humidifier is located inside the Liebert unit and is locally controlled to maintain a set point return air relative humidity at a humidistat immediately upstream of the open air filter. The humidifier is a steam injection type with condensate drain located at the bottom of the unit.

Temperature and humidity sensors located in the return air plenum of the Liebert unit control the single zone system.

During our February 13, 2013 visit, QSE noted the following Liebert unit control set points:

Heating/Cooling: 70°F

Humidification: ??% RH

Dehumidification: 50% RH

## **Gallery**

The Gallery is a 1,350 square foot exhibit space. The room has low lighting levels and a reception desk located at the entrance.

The Gallery supply air duct runs through the ceiling of the Workroom close to the wall shared with the Gallery. Supply grilles are located high on the east wall of the Gallery. Return air is drawn out of the Gallery through a grille in the south wall and ducted above the Corridor ceiling back to the Mechanical Room. Refer to Figures 4-6 attached to the end of this report for photos of the Gallery space.

## **Workroom**

The 550 square foot Workroom is used to create Gallery exhibit displays.

Conditioned air from the Liebert unit is supplied to the Workroom through linear diffusers in the supply air ductwork passing through the Workroom on its way to the Collection Storage Room. Air is returned from the Workroom to the Liebert unit through a grille mounted in the Collection Storage Room return air duct also passing through the Workroom ceiling. Refer to Figures 7-8 attached to the end of this report for photos of the Workroom space.

## **Collections Storage Room**

The Collections Storage Room is a 1,300 square foot space with rows of fixed open shelves that occupy the center and perimeter along with free-standing artifacts. In the northwest corner of the room is access to a display case which is provided for public viewing through a window in the adjacent Corridor.

The Collections Storage Room supply air ductwork passes through the Workroom and runs through the center of the Collections Storage Room ceiling. Conditioned air is discharged horizontally both east and west through grilles mounted on the sides of the duct. All Collections Storage Room return air is drawn through a wall grille and ducted back to the Mechanical Room through the Workroom ceiling. The display case is served by smaller supply and return ducts fed from the Collections Storage Room mains. Refer to Figures 9-11 attached to the end of this report for photos of the Storage Room and display case.

## Environmental Control Goals

The Goldstein Museum of Design would ideally like to achieve the following indoor environmental control objectives in the Collections Storage Room in order to better preserve the collections in their care. Gallery conditions should be similar but can be less stringent if necessary for visitor comfort.

Winter:	68°F minimum space temperature 20-40% RH minimum space humidity
Summer:	70°F maximum space temperature 50-55% RH maximum space humidity

Goldstein Museum representatives have stated that Workroom environmental control is not critical to their operations and, as such, need not achieve anything but reasonable space comfort conditions.

## Analysis

Currently, temperature control is reasonably acceptable for collections preservation. However, humidity control varies significantly as illustrated in the April-May, 2013 data logger graphs (Figures 12-13). During that month the Collections Storage relative humidity swung between about 15-50% RH, while the Gallery humidity was quite steady at about 43% RH. Collections Storage relative humidity is most critical for the Museum and, as such, QSE's recommendations include provisions for accomplishing that.

QSE believes that the current HVAC system is oversized for the Museum's environmental control requirements. It is circulating about 3 CFM/sq ft in a 100% interior space with very little cooling load (primarily just lights and a handful of people). Energy can be saved with the new system by reducing total airflow to better match the needs of the Museum. Similarly, the 20 ton cooling capacity of the Liebert unit represents 160 sq ft/ton in a space that probably needs less than half of that cooling/dehumidification capability. Right-sizing the DX cooling system should reduce electrical demand in the building and allow for more even temperature control for the Museum.

## Options

All of the following options include replacement of the existing Liebert unit and its roof-mounted condensing unit. They also all include reconfiguring the Collections Storage supply and return ductwork to accommodate the new compact storage system and to reflect the elimination of the display case in the northwest corner of Collections Storage. The recommended new ductwork layout is illustrated in Figure 14.

In addition, all of the options must include provisions for fresh air ventilation to the Museum spaces. A main building supply air duct passes through the Mechanical Room, Workroom, and Collections Storage. QSE recommends tapping into the existing main with a duct sized for minimum Code-level fresh air ventilation to be ducted into the return air of the new Liebert unit(s). The new takeoff should include a VAV box to maintain set point minimum airflow to the Museum spaces at all times when the main building system is operational. The VAV box should be controlled via the existing Johnson Controls building automation system (BAS).

This fresh air ventilation will serve to slightly positively pressurize the Museum spaces. This is desirable for improving collections environmental control by minimizing the potential for non-Museum quality air infiltrating into collections areas.

### **Option 1: New Central Liebert Unit with Gallery Electric Reheat**

Refer to Figure 15. Replace the existing Liebert unit with a new, high efficiency 10 ton (4,000 CFM) unit to serve all Goldstein Museum spaces using the existing distribution duct system (with the exception of the reconfigured Collections Storage ductwork). The new condensing unit will be located on the roof in the same location as the existing condensing unit to be removed.

The Liebert unit will be locally controlled via wall-mounted temperature and relative humidity sensors located in the Collections Storage Room. The Liebert unit controller shall be capable of seamlessly sharing (via BACNet interface) all of its input and output points with the BAS.

Install a new electric reheat coil in the dedicated Gallery supply air duct upstream of its first sidewall diffuser takeoff. Control the electric reheat via the BAS to maintain a set point space temperature at a wall-mounted sensor in the Gallery. The Gallery dew point (moisture content of the air) will be slave to the Collections Storage Room humidity control, but QSE expects the Gallery temperature set point to be similar to the Collections Storage Room temperature and, therefore, the two relative humidities should be very similar. However, the Collections Storage Room relative humidity should be the steadier of the two.

The Workroom will continue to receive some supply air from the Collections Storage duct and its space conditions will be slave to conditions in the Collections Storage Room.

Rebalance the supply airflows to all three spaces to meet their respective cooling load requirements.

### **Option 2: New Central Liebert Unit with Gallery VAV Terminal Unit**

Refer to Figure 15. Replace the existing Liebert unit as described in Option 1, but install a new BAS-controlled variable air volume (VAV) terminal unit in the Gallery supply ductwork instead of an electric reheat coil.

Ductwork modifications and temperature and humidity control will be the same as Option 1 except that the space temperature sensor in the Gallery will control the operation of the VAV in lieu of a duct-mounted reheat coil.

### **Option 3: Two New Liebert Units**

Refer to Figure 16. Replace the existing Liebert unit with two new high efficiency 5 ton Liebert units; one dedicated to the Collections Storage Room and Workroom and the other dedicated to the Gallery. Install the new roof-mounted condensing units in the same location as the existing condensing unit to be removed. Locally control each unit from wall-mounted space temperature and relative humidity sensors in the Collections Storage Room and Gallery, respectively. The Liebert unit controllers shall be capable of seamlessly sharing (via BACNet interface) all of its input and output points with the BAS.

Install the new Gallery Liebert unit in the existing Mechanical Room and tie into existing Gallery supply and return ductwork.

Install the new Collections Storage Liebert unit in the ceiling at the south end of the Workroom. Connect it to the existing Collections Storage/Workroom supply and return ductwork.

Rebalance the supply airflows to all three spaces to meet their respective cooling load requirements.

## Construction Cost Estimates

QSE estimates the construction costs to implement each of the Options to be as tabulated below. Total project costs will depend on the project delivery method (design/bid/build, design/build, etc.) and the University's project management costs. Please work with the University of Minnesota's Capital Planning and Project Management (CPPM) group to estimate the soft costs (design engineering, design architecture, project management, etc.) associated with implementing this project.

Option	Description	Construction Cost Estimate
1	New Central Liebert Unit with Gallery Electric Reheat	\$97,000
2	New Central Liebert Unit with Gallery VAV Terminal Unit	\$95,000
3	Two New Liebert Units	\$108,000

## Options Analysis and Recommendations

The following table summarizes some of the key aspects of the three options defined above. QSE has included qualitative ratings from 1 to 5 for the following features of each option.

5 = EXCELLENT

3 = GOOD

1 = JUST OKAY

## Environmental Control Effectiveness

The environmental control effectiveness category refers to the ability of the system to achieve all of the Environmental Control Goals in both Collections Storage and the Gallery.

## Energy Costs

Relative to each other, the lower the annual energy costs, the higher the rating.

## Reliability

Relative to each other, the more reliable the system (the least susceptible to failure), the higher the rating. For this evaluation, the criteria was most heavily influenced by the number of components included in the options and the proven track record of those components.

## Maintainability

Relative to each other, the lower the maintenance associated with a system, the higher the rating. Again, this rating was heavily weighted by the number of components requiring maintenance. It also takes into account any new types of components or systems which the Goldstein Museum currently does not have.



Options		Environmental Control Effectiveness	First Cost	Energy Costs	Reliability	Maintainability	Total Score
1	New Central Liebert Unit with Gallery Electric Reheat	5	5	2	5	5	22
2	New Central Liebert Unit with Gallery VAV Terminal Unit	5	5	5	5	4	24
3	Two New Liebert Units	5	3	4	5	3	20

## Recommendations

Based on the criteria tabulated above, all three options are very similar. However, if no other considerations are paramount, QSE recommends Option #2 which offers the most energy efficient operation.

## Conclusion

Once you have reviewed this report, we look forward to meeting with you and other Goldstein Museum and University of Minnesota representatives to discuss the findings and recommendations and answer any questions you may have. Please let me know when you are ready to schedule that meeting.

Thank you very much for the opportunity to work with the Goldstein Museum of Design. It has been a great pleasure. If you have any questions, please do not hesitate to call or email me (612-309-0503, Rebecca.Ellis@QSEng.com) or Steph Gallatin (612-819-2151, Steph.Gallatin@QSEng.com) anytime.

Respectfully submitted,

QUESTIONS & SOLUTIONS ENGINEERING, INC.



Rebecca T. Ellis, PE  
LEED AP BD+C, CCP, CPMP, CxA  
President

Attachments:

Figures 1-16

*File: U of M Goldstein Museum Report 062913*



Figure 1: Existing Liebert Unit



Figure 2: Existing Liebert Unit Nameplate





Figure 3: Existing Liebert Unit Control Panel



Figure 4: Gallery South Supply Air Register



Figure 5: Gallery North Supply Air Register



Figure 6: Gallery Return Air Grille



**Figure 7: Workroom Ductwork Penetrations from Mechanical Room**



**Figure 8: Workroom Supply Air Registers (left) and Gallery Supply Air Duct (right)**





**Figure 9: Collections Storage Duct Penetrations and Return Air Grille**



**Figure 10: Collections Storage Supply Air Registers (to left of lights)**



**Figure 11: Collections Storage Display Case Supply & Return Ducts**

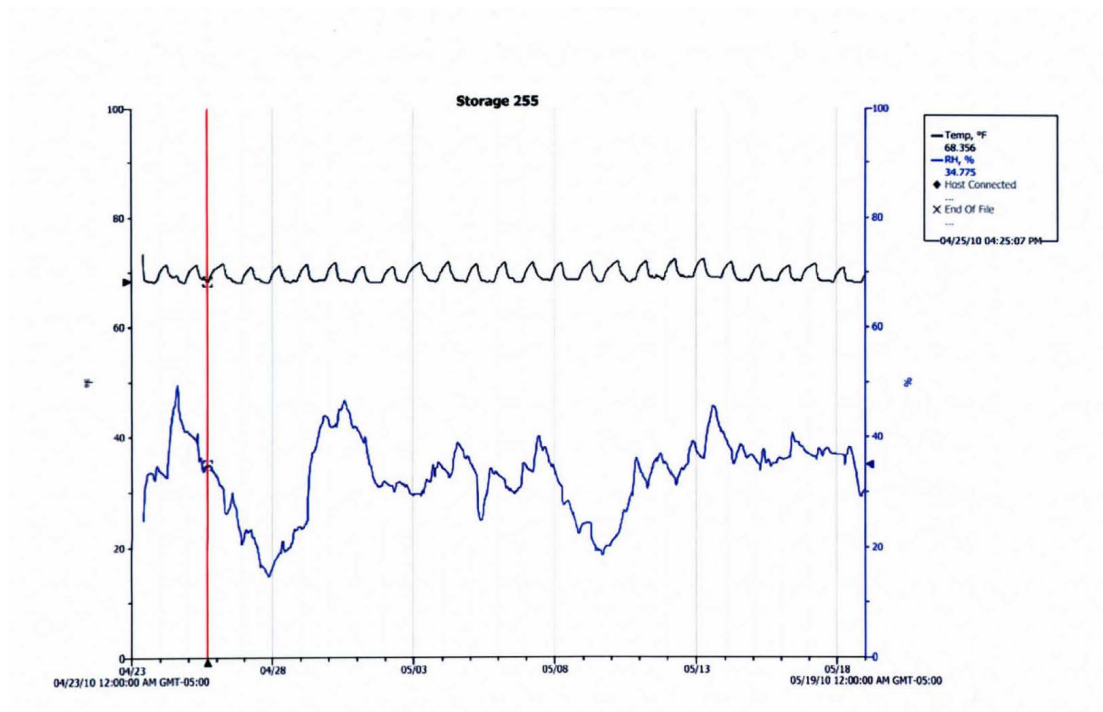


Figure 12: Collections Storage Temperatures & Humidities, April-May, 2013

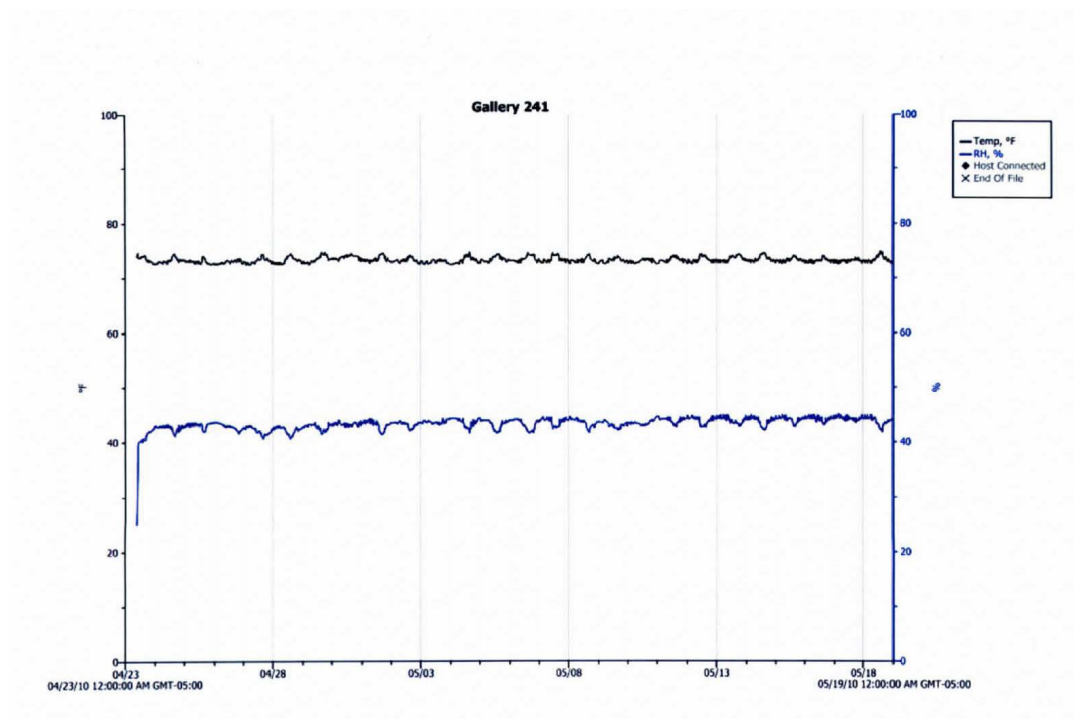
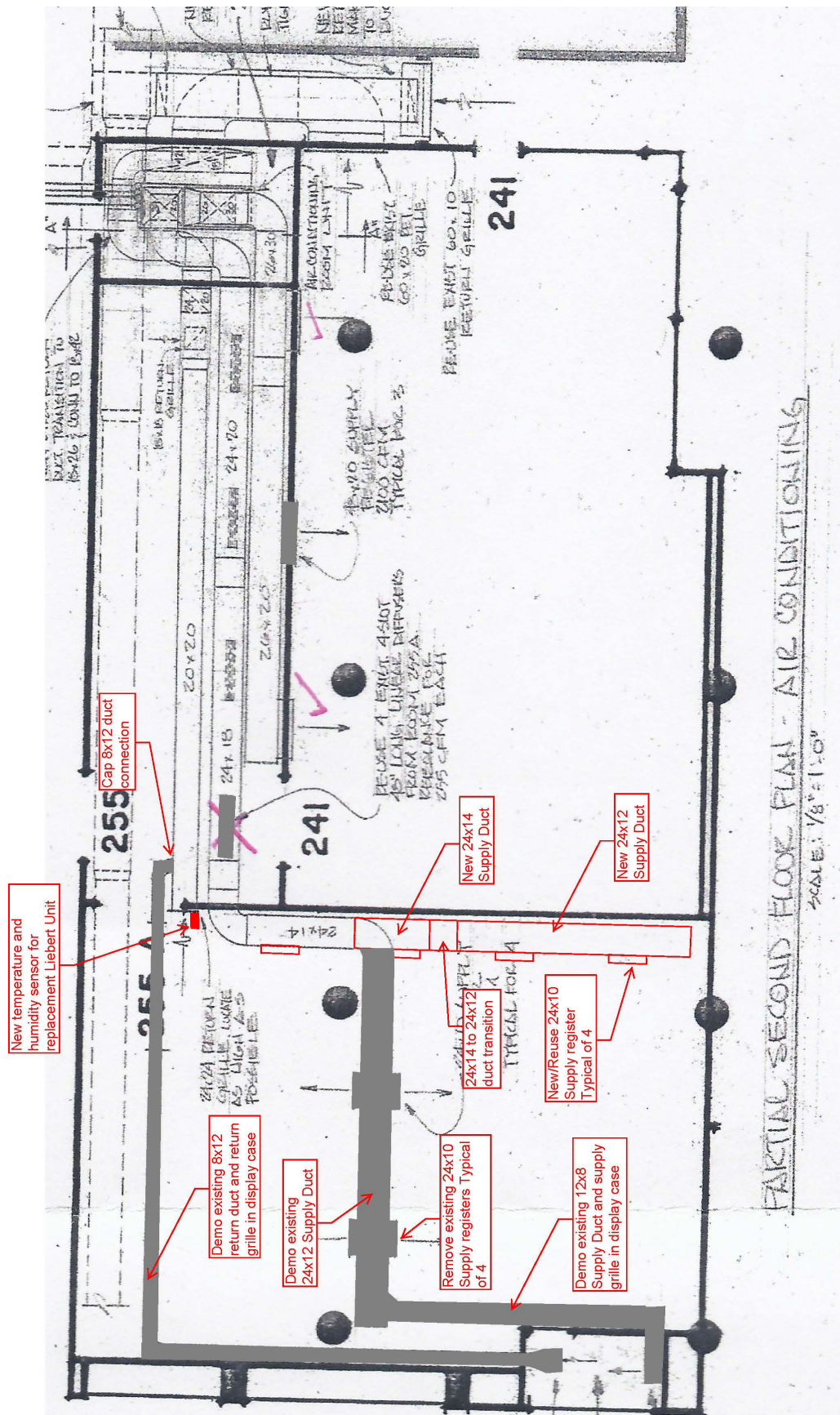


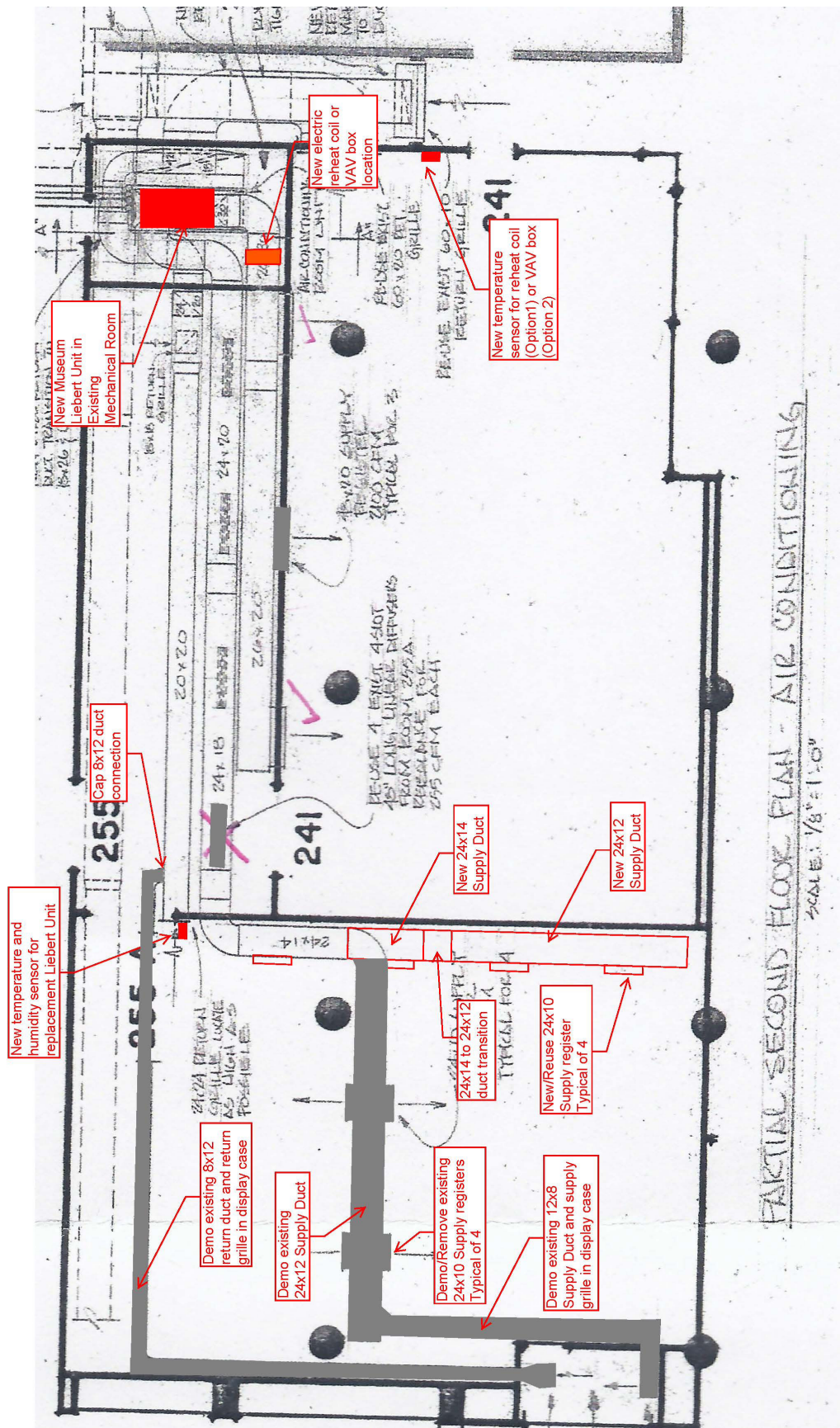
Figure 13: Gallery Temperatures & Humidities, April-May, 2013





Collections Storage Room Ductwork Modifications - All Options

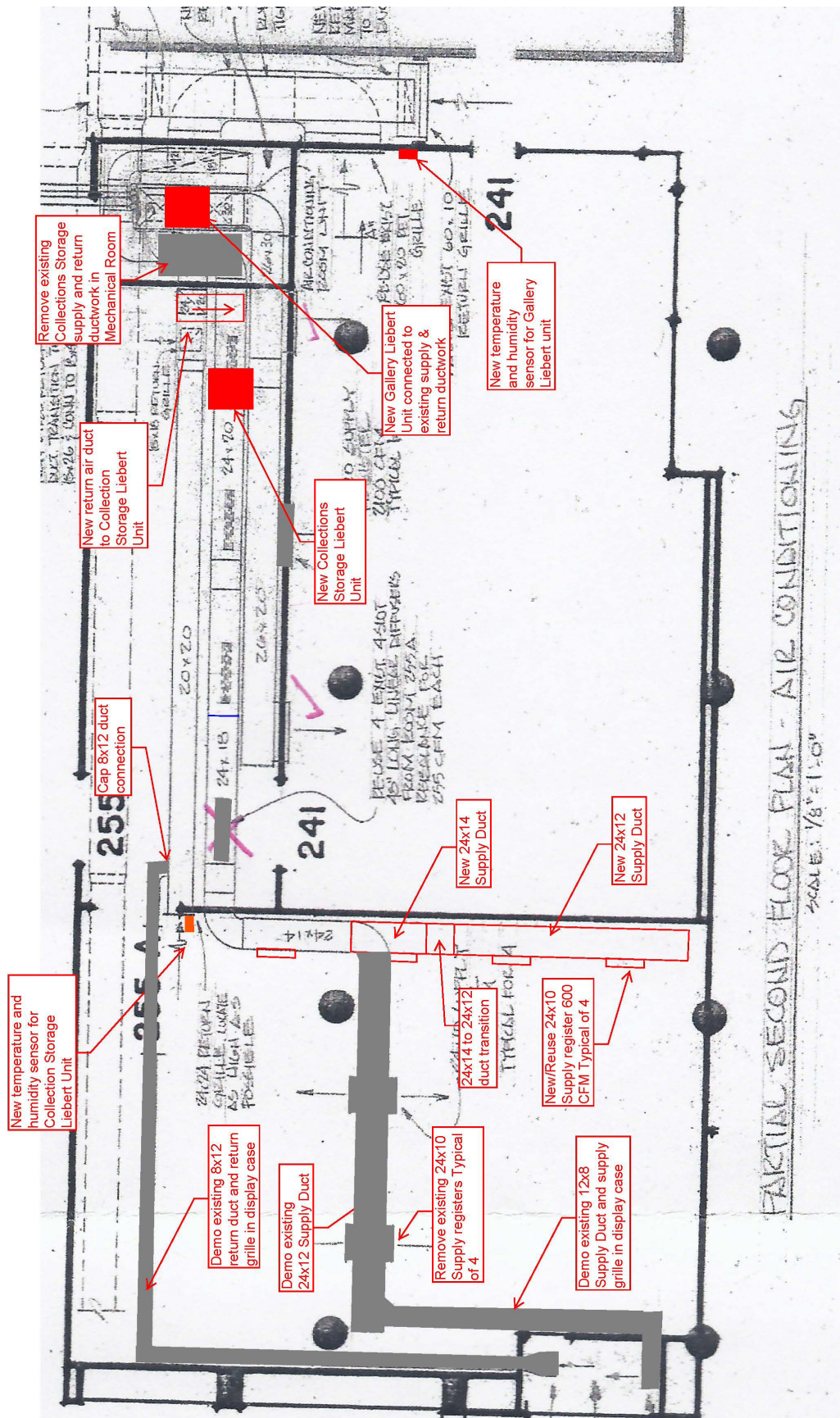
Figure 14: Collections Storage Ductwork Modifications



Options 1 and 2 Modifications

Figure 15: Options 1 and 2 Modifications





Option 3 Modifications

Figure 16: Option 3 Modifications

## **Goldstein Museum of Design Textile Storage Room 255**

Project Title: Space Planning: The Final Frontier

Institution: Goldstein Museum of Design

Project Director: Eunice Haugen

Grant Program: Sustaining Cultural Heritage Collections

### **CURRENT STORAGE CONDITIONS:**

#### **Structure/Physical Space**

The current storage space in Room 255 of McNeal Hall, home of the Goldstein Museum of Design, on the Saint Paul campus of the University of Minnesota. The storage is organized within a single room, roughly 30 feet by 42 feet (approximately 1260 square feet), constructed of painted concrete walls with a 10'8" tall ceiling of irregular construction. Room 255 is an interior space surrounded by hallways, classrooms, office, and storage spaces that are against the exterior of the building. There is one access door on the south wall and a door on the west side of the north wall opens to an adjoining closet or very small room. There are no windows. The lighting consists of hanging florescent fixtures which are operated by a wall switch within the room. Exposed duct work and utility pipes are visible. No fire suppression systems (sprinkler or extinguishers) are visible. There are two large circular pillars spaced across the approximate center of the room in a north and south alignment. Structural protrusions in each corner of the ceiling will affect the height of the proposed cabinets in those areas. The present HVAC system will also create limitations to the height of the proposed compact storage units.

#### **Storage units**

There are currently 77 free-standing garment cabinets (all approximately 84" x 42" x 24" in dimension (width x height x depth) constructed of particle board or plywood veneered with plastic laminate. They are organized in seven ranges with back to back cabinets forming each range. There are four ranges consisting of a total of 52 cabinets aligned north to south occupying the majority of the room and three ranges consisting of a total of 18 cabinets aligned east to west along the west wall. The east wall has one shelving unit. The south wall is lined with four hanging storage cabinets, three cabinets with drawers, and shelving above one drawer unit. All but one of these cabinets have boxed storage stacked above.

All cabinets are accurately labeled with basic content information and boxes are labeled with photos of the objects contained within. Virtually all the cabinets, shelves and drawers have been lined with acid-free paper to aid in preventing migration of contaminants. The interior of the cabinets, including the doors also have been lined. All objects within this storage room (and in the collection) are accounted for and catalogued: fortunately there will be few, if any, "surprises" when the storage transfer occurs.

For the purposes of this report the textiles in the collection will be referred to as two- and three-dimensional apparel/garments and two-dimensional textiles.

## **CURRENT STORAGE METHODS:**

### **Hanging:**

There are approximately 2,470 garments currently hanging in storage in Room 255. Of those hanging garments approximately 2,057 are full-length and the remaining 349 are half-length (shirts, jackets, skirts, children's, etc.)

The garments in the cabinets are draped on a variety of wooden or plastic commercial hangers: padded and covered with unbleached cotton muslin or cotton stockinet, and unpadded muslin or stockinet hanger covers. All have identification tags made of acid-free paper and cotton string.

### **Drawer:**

There are approximately 1417 textiles stored in drawers in the cabinets along the south wall. The majority of the textiles are stored flat and layered in the drawers (with and without interleaving or acid-free tissue paper). Some garments are rolled on themselves (stockings) or rolled on small tubes within drawers. Those in drawers are often compressed to maximize the capacity of each drawer.

Drawer and boxed storage currently contains approximately 212 full length garments. There are approximately 66 half-length or children's garments that GMD staff would like to change to hanging storage. Conversely, there are at present approximately 49 objects that can be transferred to another room for storage.

### **Shelves:**

Three-dimensional objects, namely hats and footwear, are stored in either boxes or on open flat shelving. They are all supported and labeled, thus making a transfer to a new storage space relatively simple.

Garments and two-dimensional textiles are also stored flat and layered on shelving (with and without interleaving or acid-free tissue paper). Other two-dimensional textiles are rolled on tubes, the tubes are on rods within garment cabinets. The rolls are supported by rods of galvanized conduit on custom made supports at varying elevations to facilitate viewing and access. Approximately 1,075 textiles are rolled. The majority of textiles in rolled storage at relatively small (flat garments, yardage, rugs, runners, etc.), however there are approximately 32 large rolls (mostly rugs) housed within the room at present.

There are several varieties and sizes of acid-free textile storage boxes utilized as is appropriate for and correspond with the contents (hat and garment). Approximately 33 garment boxes (generally 30" x 18" x 6 or 40" x 18" x 6" in size) are contained within cabinets and 246 boxes are on top of cabinets and together house approximately 2,292 textiles, 527 hats and 1765 costume pieces. There are 212 dresses that are currently in boxes that could be transferred to drawers. There are approximately 100 hat boxes: the majority are non-archival (11-1/2" x 16-1/4" x 19-1/4") and the remainder are archival (12-1/4" x 14" x 14").

### **Rolled:**

There are approximately 1075 textiles rolled and stored on racks within Room 255. The widest roll is 10 feet wide and it is a rug.

### **RECOMMENDED STORAGE IMPROVEMENTS:**

The recommended combination system should accommodate the extant collection and will provide:

- appropriate hanging, rolled, or flat storage of the collection;
- protection from light and air pollutants;
- protection from physical damage;
- mitigation of contact contaminants;
- enclosed protection of the collection as a large group; and
- additional security from vandalism or theft.

While the majority of the garments can continue to be stored hanging, there are some which should be stored flat and conversely others that are stored flat which can be hung.

Overall the collection can be accommodated by the three basic type of storage: hanging, flat, or rolled. All three types of required storage can be most efficiently housed within commercially available baked powder-coated steel cabinets. Research into the variety of cabinets on the market and inquiries into the availability of preferred cabinetry components helped to determine the best options are available from Delta Designs Ltd. Garment storage in room 330 at GMD utilizes the Spacesaver compact storage system, Steele Fixture and Delta Designs cabinets and garments stored in room 166 (the International Collection) are contained within five Delta Designs cabinets.

### **Storage Units** (ranked in order of highest priority/strongest recommendation)

Due to the restrictions created by the dimensions of the one access door and the freight elevator, the height of the cabinets is limited. Two-part units have been recommended by the vendor.

### **Compact Garment Storage**

The majority of the collection can be housed within forty 58" x 79" x 32" (width x height x depth) solid door cabinets topped with 58" x 23" x 32" Delta Design 700 series cabinets using a Spacesaver compact storage system. The Spacesaver System is proposed to occupy the area in the room currently occupied by the two different ranges of garment cabinets.

### **Shelving**

Open shelving could be used to house the items currently stored in boxes and rolled storage.

### **ENVIRONMENTAL RECOMMENDATIONS;**

These recommendations are based on the guidelines produced by the Canadian Conservation Institute (Canadian Conservation Institute. *Textiles and the Environment*. CCI Notes 13/1. Ottawa: Canadian Conservation Institution, 2013.)

## **Light**

A continuation of the current practice of little to no lighting in the room when it is unoccupied is highly recommended. Even with the proposed enclosed storage cabinets, the lack of lights when the room is unoccupied is good for any textile that might be removed from storage and is temporarily on a rolling rack or examination table for study, movement, examination, etc. Currently the standard light level recommendations for display are a maximum of 50 lux (5 foot candles) and ultra violet (UV) light should be eliminated. Light exposure is cumulative and irreversible, especially with textiles. Damage occurs to textiles by the intensity of the light, the proportion of UV radiation, and the length of exposure.

## **Relative Humidity**

The most recent Hobo Temperature and RH Data Logger recording of the relative humidity (RH) in Room 255 over seven and a half months in 2013 (March 8 through October 28) indicates an average of 48.5% with maximum RH at 65% and minimum at 24%. The low RH was during the cold months.

Ideal relative humidity is 50% with fluctuations of +/- 5 percent. Textiles can withstand very gradual and limited fluctuations in temperature and RH, but extremes can be damaging: high RH levels (over 60%) can encourage fungal growth, while low RH levels (below 20%) can lead to the desiccation and embrittlement of natural fibers and feathers.

Textile fibers have a capacity for retaining a certain level of moisture. As the surrounding relative humidity fluctuates, it causes the textile to react. A high relative humidity causes textile fibers to swell with absorbed water and initiate reactions such as dye bleeding, yellowing, browning and biological deterioration (mold). Low relative humidity will cause the fibers to release moisture and shrink. Rapid changes in the relative humidity causes rapid shrinking and swelling in the materials, resulting in damage to the fibers. Some variation in RH is acceptable, but wide fluctuations within short periods of time should be avoided. The damage created by the above-mentioned factors is cumulative and irreversible. Additionally, proximity to many metals needs to be considered, even items such as buttons may have to be isolated in composite objects. Under humid conditions metals can rust, corrode and cause staining.

## **Temperature**

The most recent Hobo Temperature and RH Data Logger recording of the temperature in Room 255 over seven and a half months in 2013 (March 8 through October 28) indicates an average temperature of 71.1 degrees Fahrenheit with maximum temperature of 75.7 and minimum of 61.4 degrees Fahrenheit. The greatest difference in temperature occurred during scheduled power outages in the middle of June, factors beyond the control of the Museum.

Colder storage is ideal for textiles, with guidelines of approximately 60-68 degrees Fahrenheit in winter and 68-75 degrees Fahrenheit in summer. Storage areas, however can be cooler with a guideline of 50 to 55 degrees Fahrenheit. Items with fur can require

lower temperatures. For fibers, lower temperatures are preferable since each 10 degree rise in temperature can cause the rate of a chemical reaction to double.

### **STORAGE METHOD RECOMMENDATIONS:**

While each institution has their own system of organizing their collections, the staff at the GMD has in place a very good and effective system of organization among the apparel items and there is no reason to alter this system. They currently maintain and organize women's apparel and men's apparel separately in chronological order as much as is possible in the current storage space in Room 255. Full length apparel are housed together, whether hanging or flat storage. Two piece garments are and can continue to be stored with the bodice hanging in the upper level of the cabinet and the coordinating skirt hanging on the lower level of the same cabinet. Outerwear is typically housed together as are undergarments. While there are always exceptions to any rule, storing like with like (footwear together, hats together, etc.) often will reduce contamination of susceptible items: leather items such as shoes and boots will be together; fur and feather adornments typically are on outerwear and haute couture, and the dominance of these embellishments can be cyclical and related to specific periods in fashion and thus likely to be stored together. It is the care of individual types of apparel items that will be address in this section.

#### **Three-Dimensional Apparel, Hanging Storage**

The vast majority of items currently hanging in storage can be transferred to the new cabinets with little or no change. There may be several garments that could benefit from specially constructed hangers which will better support unique shoulder silhouettes. This, however, is a matter of detail and not critical at this point to the safe storage of the items.

Custom hanging garment covers made of lightweight Hollytex (100% polyester white non-woven) could lessen the likelihood of loss of feather, fur, or abrasive (sequins, beading, or bouillon) embellishments.

#### **Three-Dimensional Apparel, Flat Storage**

Items currently stored flat in drawers or boxes (undergarments, bathing suits, bibs, aprons, scarves, etc.) should be transferred to the new drawer storage and be interleaved as described below. Effort should be made to reduce compression of items currently stored in overstuffed drawers. The boxed items are less compressed and could stay in their current storage container and relocated as is into the new storage shelving. Any non acid-free boxes however, should be lined to prevent migration of contaminants or placed in new acid-free storage boxes. The new cabinets and shelving can accommodate either of the commercially available typical acid-free garment storage box sizes, 30" or 40" x 18" x 6". The use of these boxes will require the use of interleaving.

Hats: These items may stay in their current storage units (specifically hats in boxes) or could be transferred to drawers or shelves. Any non acid-free boxes should be lined to prevent migration of contaminants or the hats should be placed in new acid-free storage boxes. The new cabinetry will accommodate all the current hats in Room 255.

### **Two-Dimensional Apparel and Textiles, Flat Storage**

Interleaving should be used when multiple items are stored in boxes, drawers, or shelves. Interleaving provides a physical barrier between the textiles to prevent migration of dyes and colorants and reduce abrasion from non-smooth embellishments. Interleaving also can assist in decreasing handling of flat storage items if the interleaving can act as a sling and provide support when the garment is moved. Commonly used interleaving supplies are acid-free tissue paper, acid-free paper, spun-bonded fabric such as Reemay or Hollytex, or woven fabrics such as muslin or a poly/cotton blend plain-weave.

Smaller two-dimensional textiles in the GMD collection, namely some of the approximate 300 handkerchiefs and 800 scarves, could be housed, or encapsulated, within archival sleeve- or folder-like enclosures constructed of polyester film and Reemay or Hollytex with side seamed. These folder-like enclosures will provide safe handling format of encapsulation, lessen the chance of abrasion, and separate the uniquely sized items into a more uniform dimension making it easier to store them in drawers or boxes.

### **Two-Dimensional Apparel and Textiles, Rolled Storage**

Some two-dimensional textiles, which are not accessed frequently or of a unique or cumbersome size (such as long narrow scarves), could be rolled for storage. These items should be rolled on an acid-free or adequately prepared tube (a sturdy cardboard tube can be used but should be covered with polyethylene plastic sheeting, polyester film, or MarvelSeal 360 over which is placed unbleached cotton stockinette, washed cotton muslin fabric, acid-free tissue paper or acid-free paper) for storage. The textile is rolled from one end, ideally with the tube perpendicular to the warps with the face or front of the textile on the outside of the tube (there are exceptions to this rule.) When the other end of the textile is reached, a length of washed cotton muslin fabric, or any of the above listed materials, is placed along the inside of the free end, and rolling continues until the fabric completely covers the textile. A collar is cut from heavyweight acid-free paper and placed around the rolled and covered textile. A length of narrow twill tape is placed over the collar and tied with a bow. The collar prevents the tie from pinching and potentially damaging the textile. An identification tag may be attached to either the twill tape or the outerlayer of fabric.

### **TRANSITIONING TO NEW SPACE:**

The GMD staff has proposed closing Gallery 241 in McNeal Hall and to use this space as temporary storage while Room 255 is emptied of collection, the old storage units removed, demolition, addition of any mechanical or structural upgrades, and finally installation of the new storage system.

All loose items (non-boxes, non-hanging, etc.) should be removed first. They can be placed in temporary storage such as boxes, tubs, and on carts prior to moving to the Gallery.



Boxed items should be removed via carts and either stacked on the floor or placed on temporary shelving. Care should be given to not stack more than four boxes high, and less for hat boxes.

Temporary hanging supports should be created, i.e. from rods secured between shelving or special temporary supports for the rods can be made. Hanging garments should be transferred via the use of extant rolling hanging racks. This process will be time consuming due to the volume of hanging garments, the method in which they should be carefully moved (preventing unnecessary movement and abrasion), and the distance they must travel from Room 255 to the Gallery 241. Exceptional care should be given to maintaining the order of the items from each storage unit.

The hanging garments should be covered with fabric or Tyvec dust covers. This will reduce exposure to light, airborne dust, and hopefully unnecessary handling or touching.

Once Room 255 is outfitted the registrar/collections manager may have a specific order in which they wish to install the collection.

## **VENDORS AND SUPPLY SOURCES:**

### **Acid-Free Tissue Paper, Unbuffered:**

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-1912, [www.universityproducts.com](http://www.universityproducts.com)

### **Archival L Enclosures:**

Gaylord, PO Box 4901, Syracuse, NY 13221-4901, 800-448-6160, [Gaylord.com](http://Gaylord.com)

Hollinger Metal Edge, 9401 Northeast Dr., Fredericksburg, VA 22408, 800-634-0491, or 6340 Bandini Blvd., Commerce, CA 90040, 800-862-2228, [hollingermetalede.com](http://hollingermetalede.com)

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-1912, [www.universityproducts.com](http://www.universityproducts.com)

### **Acid-Free Corrugated Textile Storage Boxes, 30" x 18" x 6" or 40" x 18" x 6"**

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-1912, [www.universityproducts.com](http://www.universityproducts.com)

### **Compact Storage System:**

Haldeman-Homme, Inc., 430 Industrial Boulevard, Suite 200, Minneapolis, MN 55413, Phone: 612-331-4880 or 800-795-0696, Fax: 612-378-2236, [www.haldemanhomme.com](http://www.haldemanhomme.com)

SpaceSaver Corporation, 1450 Janesville Ave., Fort Atkinson, Wisconsin 53538, 800-492-3434, [www.spacesaver.com](http://www.spacesaver.com)



**Enclosed Storage Cabinets with Hanger Rods, Drawers and Shelves:**

Delta Designs Ltd, PO Box 1733, Topeka, KS 66601, 785-234-2244,  
[www.deltadesignsltd.com](http://www.deltadesignsltd.com)

Haldeman-Homme, Inc., 430 Industrial Boulevard, Suite 200, Minneapolis, MN  
55413, Phone: 612-331-4880 or 800-795-0696, Fax: 612-378-2236,  
[www.haldemanhomme.com](http://www.haldemanhomme.com)

**Ethafoam:**

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-  
1912, [www.universityproducts.com](http://www.universityproducts.com)

**Fabric, Cotton or Polyester Knit:**

Hancock Fabrics, [www.hancockfabrics.com](http://www.hancockfabrics.com) or local store

JoAnn Fabric and Craft Stores, [www.joann.com](http://www.joann.com) or local store

TestFabrics, Inc., 415 Delaware Ave., West Pittston, Pennsylvania 18643, 570-603-  
0432, [www.testfabrics.com](http://www.testfabrics.com)

Also available on-line or at most fabric/sewing stores

**Fabric, Unbleached Cotton Muslin:**

Hancock Fabrics, [www.hancockfabrics.com](http://www.hancockfabrics.com) or local store

JoAnn Fabric and Craft Stores, [www.joann.com](http://www.joann.com) or local store

TestFabrics, Inc., 415 Delaware Ave., West Pittston, Pennsylvania 18643, 570-603-  
0432, [www.testfabrics.com](http://www.testfabrics.com)

Also available on-line or at most fabric/sewing stores

**Hollytex:** white 100% polyester non-woven (calendared smooth surface)

Talas, 330 Morgan Ave., Brooklyn, NY 11211, 212-219-0770, [www.talasonline.com](http://www.talasonline.com)

The Home Depot, [www.homedepot.com](http://www.homedepot.com) or local store (Drainage Systems Filter  
Fabric)

**MarvelSeal 360:** aluminized nylon and polyethylene barrier film

Gaylord, PO Box 4901, Syracuse, NY 13221-4901, 800-448-6160, [Gaylord.com](http://Gaylord.com)

Talas, 330 Morgan Ave., Brooklyn, NY 11211, 212-219-0770, [www.talasonline.com](http://www.talasonline.com)

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-  
1912, [www.universityproducts.com](http://www.universityproducts.com)

**Padded Hangers:**

TestFabrics, Inc., 415 Delaware Ave., West Pittston, Pennsylvania 18643, 570-603-0432, [www.testfabrics.com](http://www.testfabrics.com)

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-1912, [www.universityproducts.com](http://www.universityproducts.com)

Also can be made in-house, especially for unique garments.

**Polyester Film (Mylar)**

Talas, 330 Morgan Ave., Brooklyn, NY 11211, 212-219-0770, [www.talasonline.com](http://www.talasonline.com)

University Products, 517 Main St., PO Box 101, Holyoke, MA 01041-0101, 800-628-1912, [www.universityproducts.com](http://www.universityproducts.com)

**Reemay:** white 100% polyester non-woven

Talas, 330 Morgan Ave., Brooklyn, NY 11211, 212-219-0770, [www.talasonline.com](http://www.talasonline.com)

**Stockinette Tubing: natural cotton or poly/cotton:** orthopedic stockinette

Bird & Crownin Inc., 1200 Trapp Road, Eagan, Minnesota 44121, 651-683-1111, 800-328-1095, [www.birdcronin.com](http://www.birdcronin.com)

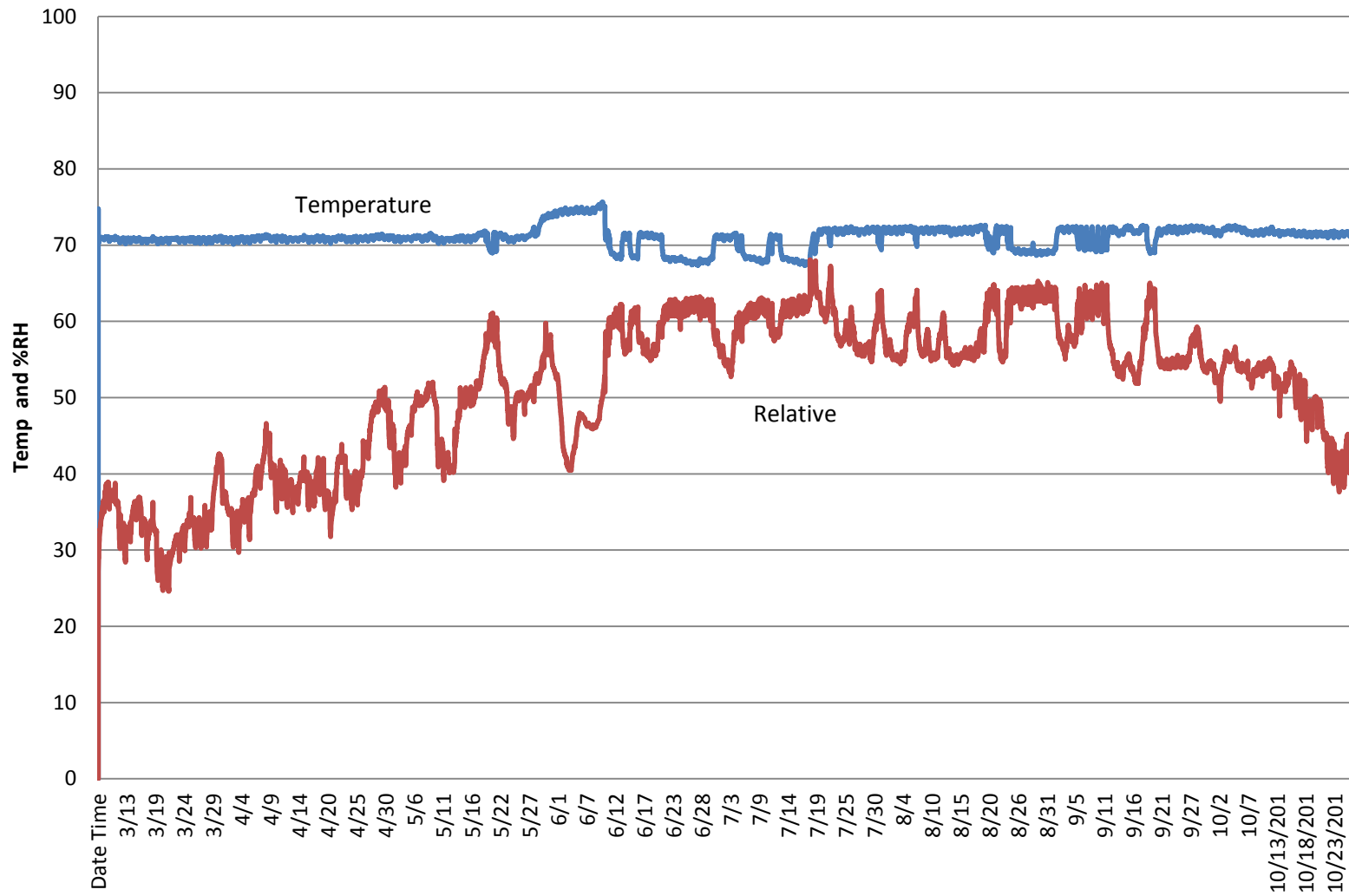
Comfort Products, Inc., 705 Linton Ave., Croydon, Pennsylvania 19021, 215-781-0300, [www.comfortoandp.com](http://www.comfortoandp.com)

Also available on-line or at medical supply stores

Beth McLaughlin  
Textile Conservator  
Fiber Art Preservation LLC  
266 Griggs Street South  
Saint Paul, Minnesota 55105  
651-334-3776  
[fiberartpreservation@gmail.com](mailto:fiberartpreservation@gmail.com)

November 12, 2013

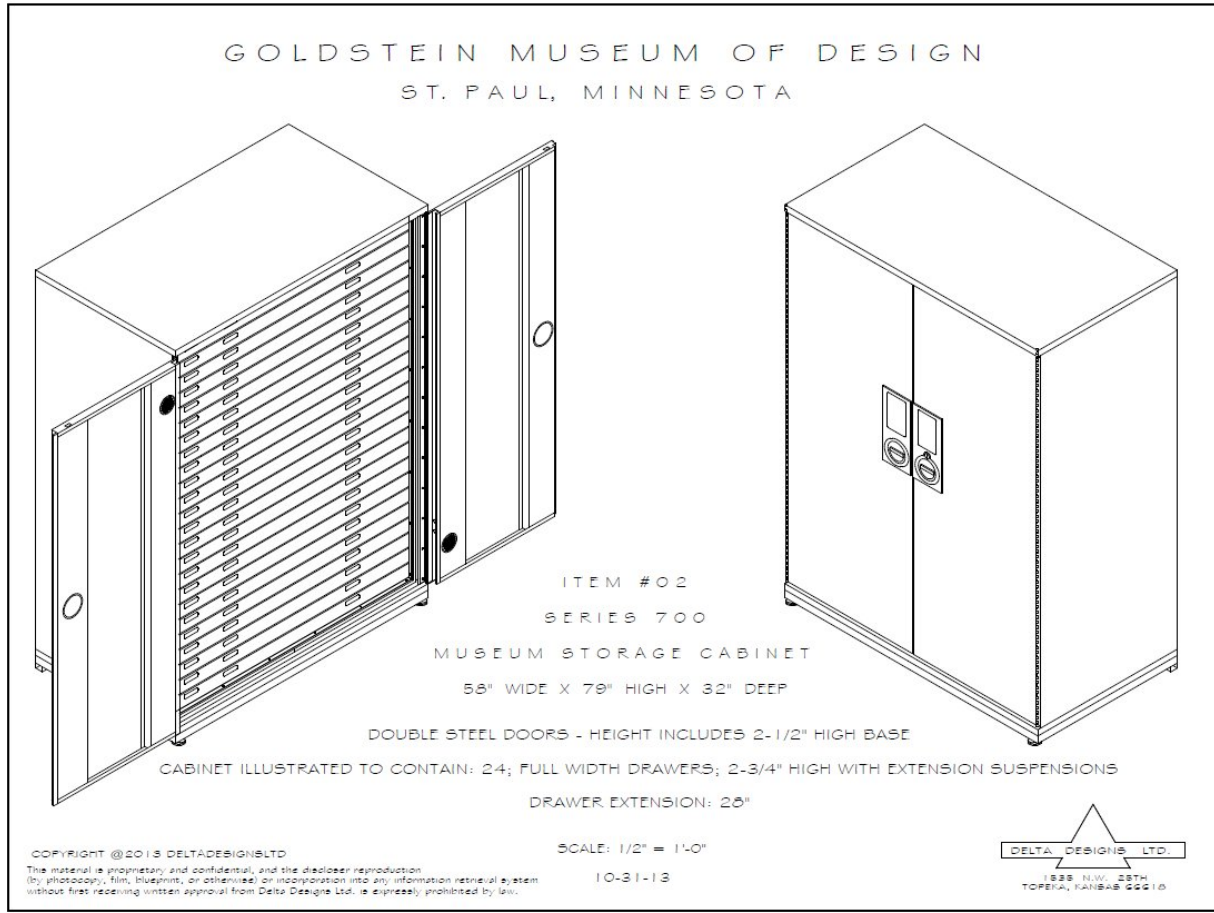
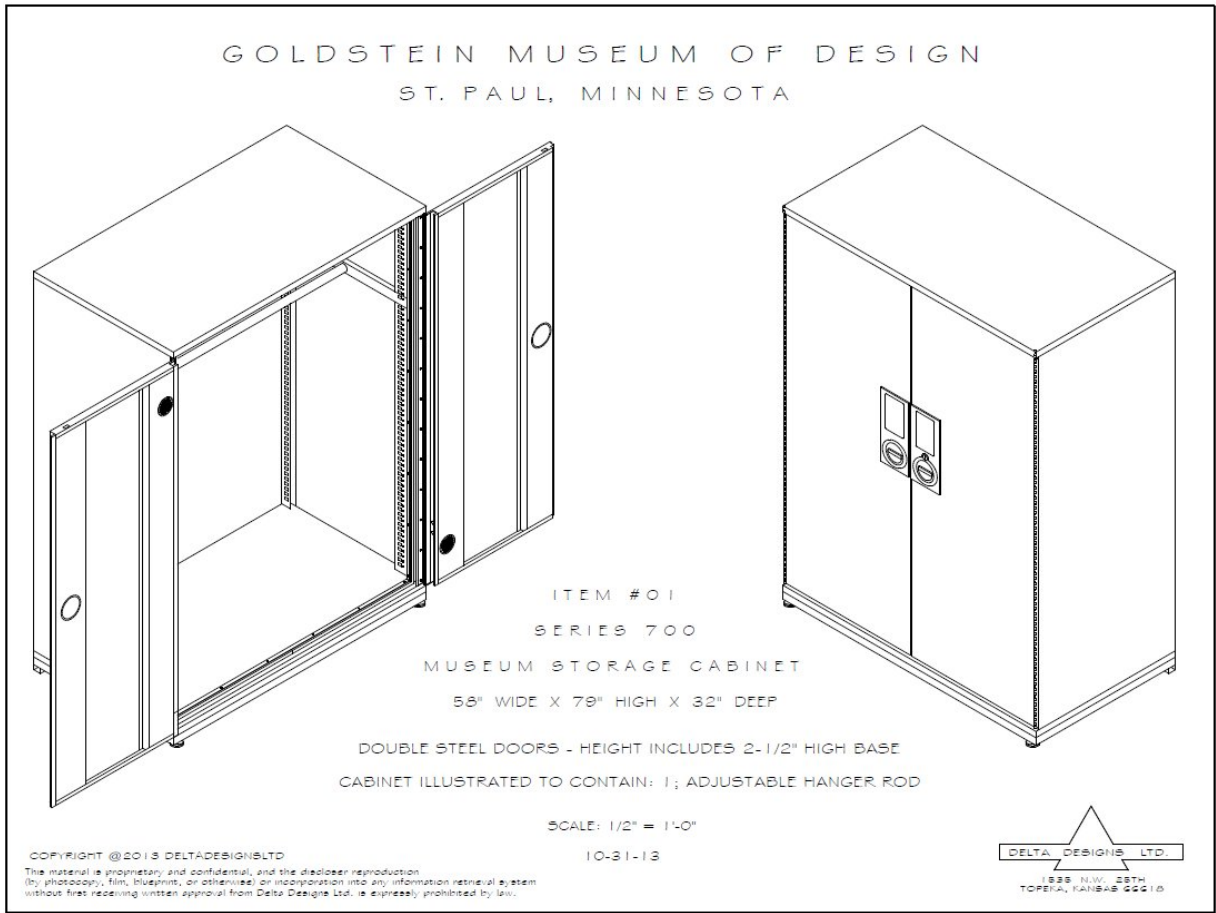
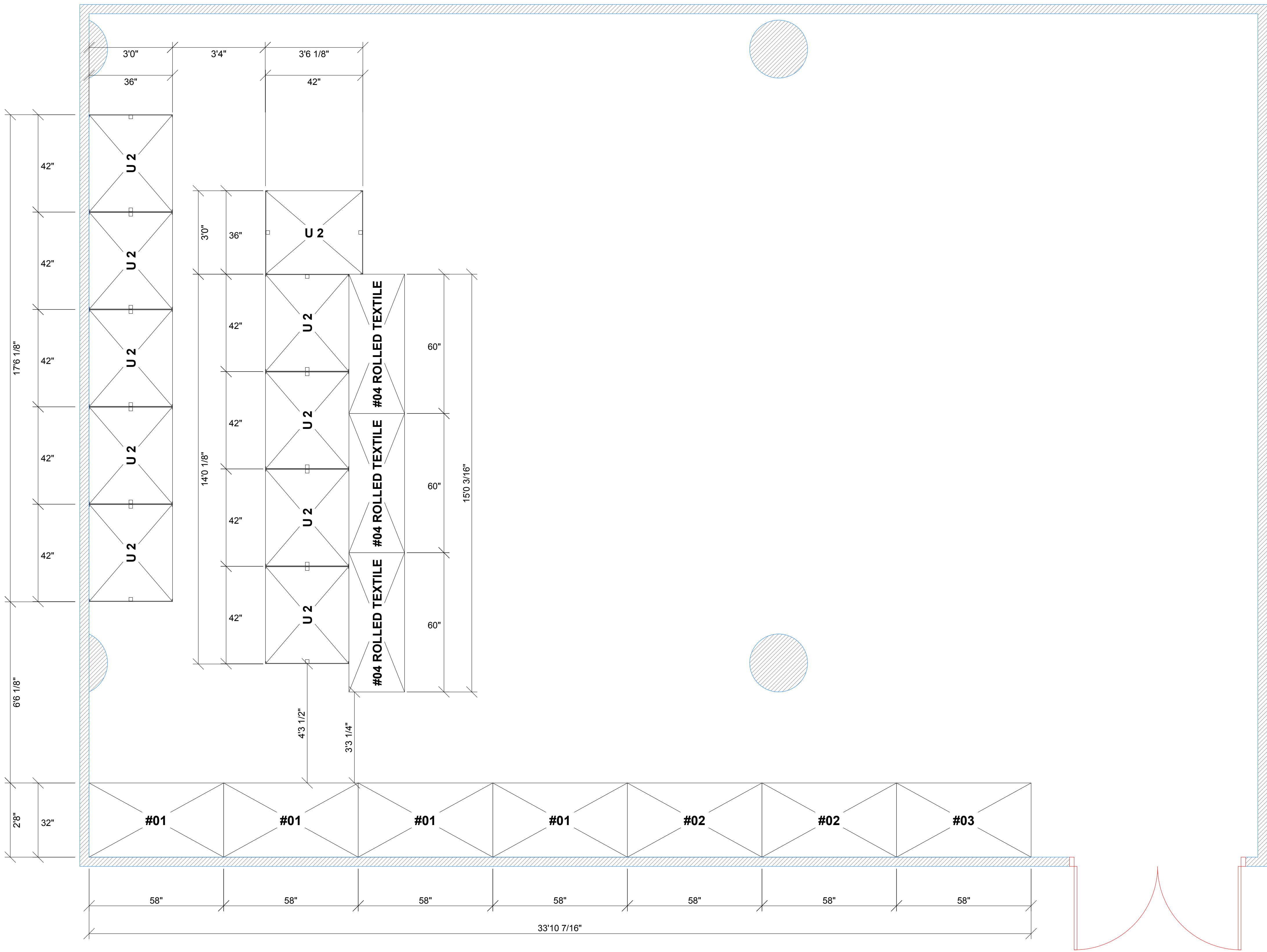
## Climate Temperature and % RH Storage Room 255 March - Oct 2013





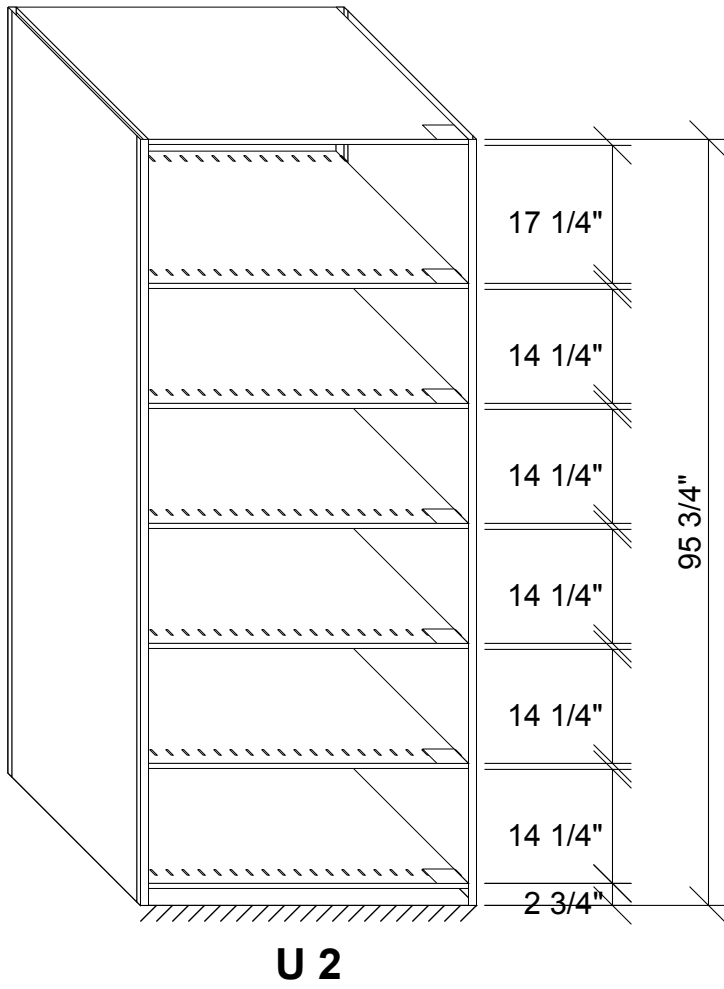
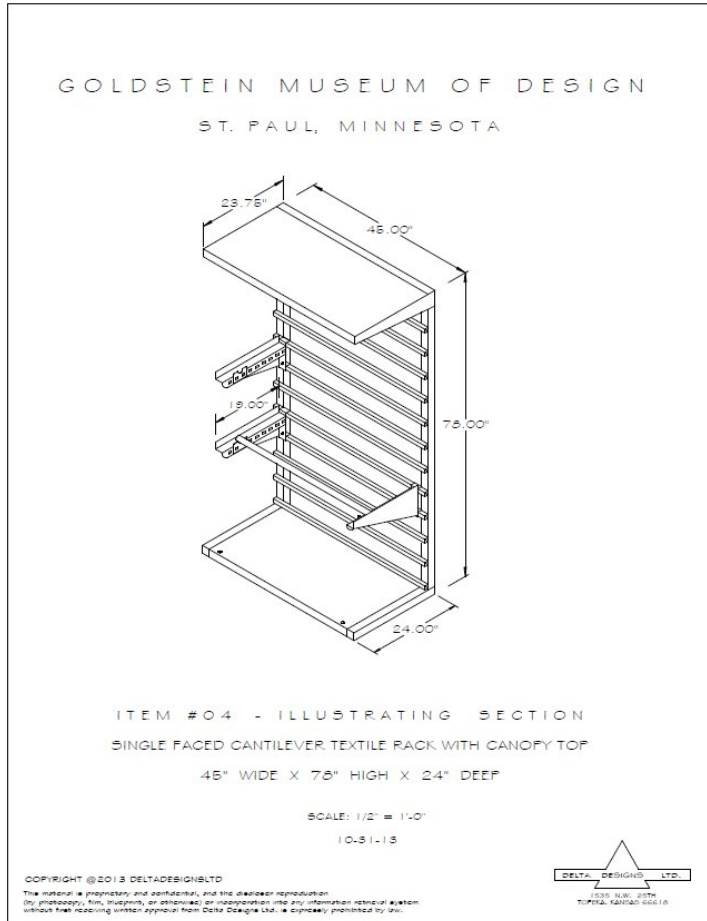
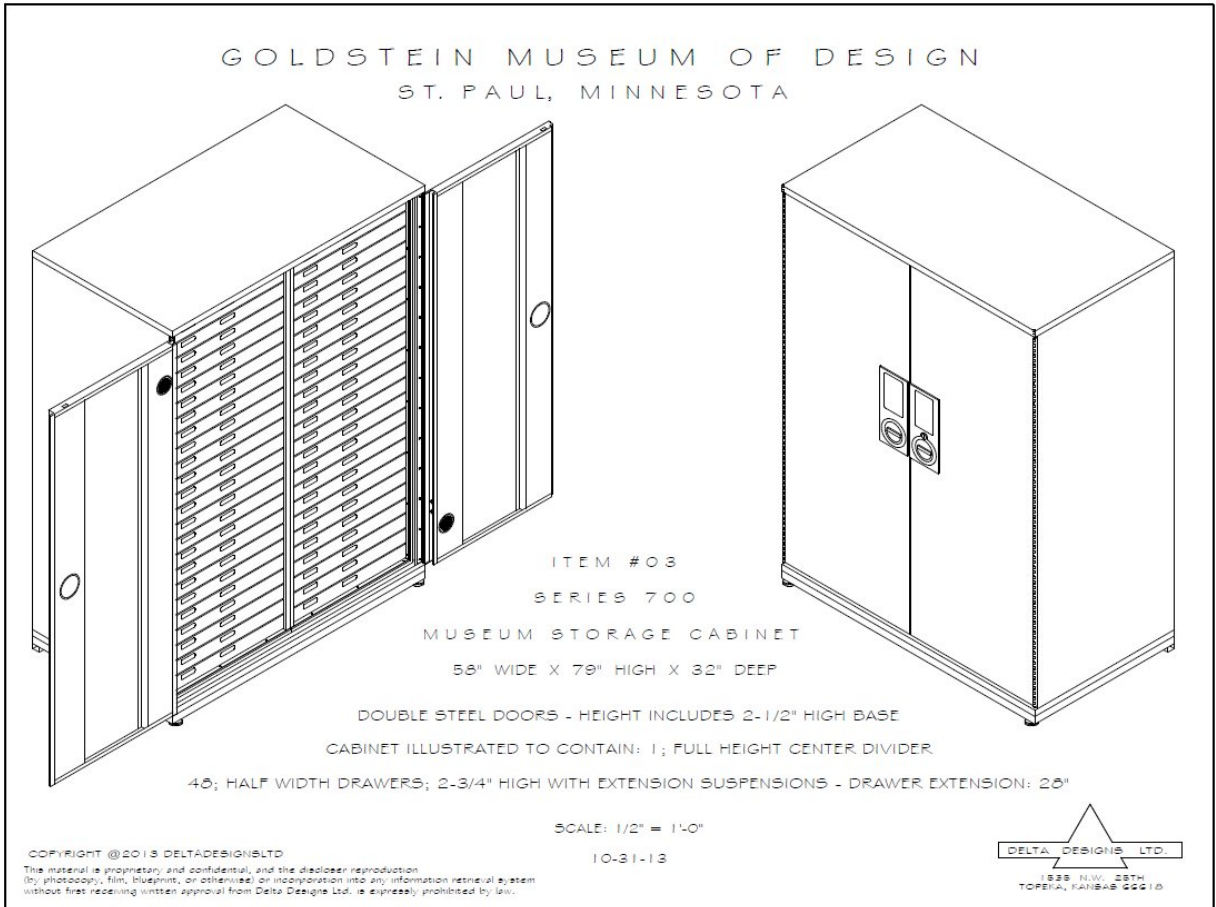


UNIVERSITY OF MN  
GOLDSTEIN SCHOOL OF DESIGN  
STATIC W/ 07 DELTA CABINETS - OPT 2



#01	79" x 58 1/16" d32"
#02	79" x 58 1/16" d32"
#03	79" x 58 1/16" d32"
#04	ROLLED TEXTILE 78" x 60 1/16" d24"

H95 3/4"  
95 3/4"x42" d36"



U 2



Project Name: U OF MN GOLDSTEIN

Salesperson:  
FRANK.DAVID

Scale  
1/2" = 1'

Rev level:  
DE

Project #:  
HH21803

Drawn by:  
FJP

Date Printed:  
11/14/2013

APPROVAL  
This drawing Approved By:  
Dated:



UNIVERSITY OF MN  
GOLDSTEIN SCHOOL OF DESIGN  
STATIC W/ 11 DELTA CABINETS - OPT 1

